Abstract

This research addresses the critical need to quantify air emissions from dairies in California with the aim of developing a process-based farm emission model that can be used as a tool for estimating and predicting emission rates of primary air pollutants and developing effective strategies for emission mitigation. Specifically in this project, the emissions of volatile organic compounds (VOCs) from silage and dairy manure were investigated due to their importance to the air quality problems of the state. It was found that among the many VOCs emitted, alcohols (ethanol and methanol) are the predominant VOCs emitted from silage sources and volatile fatty acids (VFAs), especially acetic acid, are the major VOCs emitted from manure sources. A computer model has been developed for predicting the ethanol emission rate from silage exposed to an open air environment. The model can be used to estimate the ethanol emission rate and total emission from the silage that contain different initial ethanol concentrations and exposed to different temperatures and air velocities. Further development and testing of the emission model is needed for its application to other scenarios such as ethanol emissions during silage mixing and from deep silage layers or piles. Experimental investigations were conducted to determine the generation and emission of VFAs and alcohols from dairy manure as it undergoes microbial degradation under different conditions that are typically encountered in free stall housing and manure storages. Ethanol generation and emission from fresh manure collected in the animal housing over a 24-hour period were measured and modeled. The results from the manure storage experiments showed that the initial solids content in the manure and storage temperature were significant factors influencing the microbial activities and their products. Mathematical models and computer algorithms were developed to estimate the generation and emission rates of acetic acid and other VFAs from dairy manure storages over time under different environmental conditions. The emission model was used to predict the emission rate of acetic acid from a dairy manure lagoon for different time of the year and the strong influences of air temperature and wind velocity on the emission rate were clearly shown. The emission models developed in this project are currently being incorporated into a windows based computer modeling software for dairy emissions, which is supported by a research grant from the National Milk Producers Federation.